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16. ABSTRACT This report describes the progress made during the initial quarter of Bureau of Reclamation's LANDSAT follow-on investigation. This investigation is being conducted within the Bureau's Colorado River Basin Weather Modification Program, with primary emphasis away from the demonstration and testing of the LANDSAT Data Collection System toward its use as an operational tool in monitoring weather conditions for cloud seeding control. Five LANDSAT Data Collection Platforms were operated during the reporting period and proved to be reliable weather resistant units suitable for the collection of hydrometeorological data from remote, severe winter environments. The data relayed by LANDSAT satellite were available in near real-time for project forecasting. A significant accomplishment toward improving the LANDSAT DCS was the development of a system for averaging wind speed and wind direction data and on-site storage of hourly averaged data. (E76-10102) USE OF THE LANDSAT-2 DATA COLLECTION SYSTEM IN THE COLORADO RIVER BASIN WEATHER MODIFICATION PROGRAM Progress Report, 1 Jan. - 31 Mar. 1975 (Bureau of Reclamation) 11 p HC \$3.50 N76-16525 Unclas 00102 CSCL 04B G3/43			
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USE OF THE LANDSAT-2 DATA COLLECTION SYSTEM IN THE
COLORADO RIVER BASIN WEATHER MODIFICATION PROGRAM

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Type II Progress Report
LANDSAT-2

- a. Title: Use of the LANDSAT-2 Data Collection System in the Colorado River Basin Weather Modification Program

LANDSAT Follow-on Investigation No.: 23030

- b. GSFC ID No. of P.I.: IN024

- c. Problems:

For the period from January 1, 1975 through March 31, 1975, there were no problems impeding the progress of this investigation.

- d. Accomplishments:

This section of the Progress Report discusses the accomplishments during the present reporting period and those planned for the April 1, 1975 through June 30, 1975 period.

I. Purpose of Investigation

This investigation is one developed within the Bureau of Reclamation's on-going program which will allow continued evaluation of the LANDSAT Data Collection System (DCS) from a user's viewpoint. The investigation is being conducted within the Bureau's Colorado River Basin Weather Modification Program, with primary emphasis away from the demonstration and testing of the LANDSAT DCS toward its use as an operational tool in monitoring weather conditions for cloud seeding control. Data from remote sites in the San Juan Mountains in southwestern Colorado are being relayed via the satellite to provide near real-time data for project forecasting, as well as information for past analysis.

II. LANDSAT Data Collection System for the 1974-75 Winter Season

A meeting was held with Bureau contractors and other water users to determine the best locations and configurations for the seven LANDSAT Data Collection Platforms available for the LANDSAT follow-on program. Decisions on measurements and locations were based mainly on using the LANDSAT Data Collection System operationally on the Colorado River Basin Pilot Project to provide near real-time data for project forecasting. Three criteria were established on which these decisions were based: (1) eliminate duplication of data from existing ground link data sites; (2) improve the usefulness of wind data; and (3) improve turnaround time in getting the data back to the field and distributed to the users. Figure 1 shows the selected locations for the LANDSAT Data Collection Platforms for the 1974-75 winter season. Corresponding station data for the seven sites are listed in Table 1.

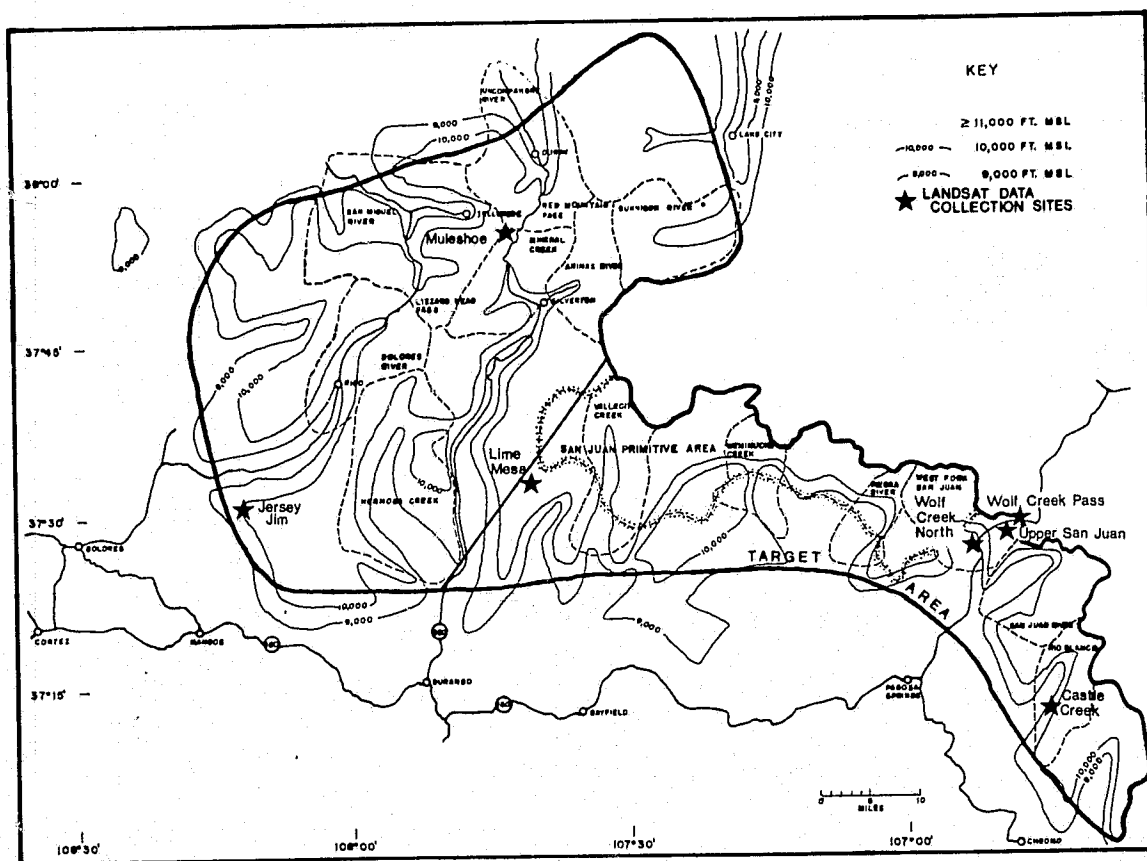


Figure 1: Location of LANDSAT field sites, 1974-75.

Station	Computer ID	DCP ID	WSSI ID	Date Installed	Lat.N.	Long.W.	Elev.(ft.)	County
Lime Mesa	LIMESA	6347	JH1	10/26/74	37° 34	107° 41	11,700	La Plata
Upper San Juan	UPRSAJ	6025	KN2	10/25/74	37° 29	106° 50	10,200	Mineral
Wolf Creek Pass	WLFCRP	6241	JO1	10/25/74	37° 29	106° 48	10,810	Mineral
Wolf Creek North	WLFCRN	6040	KN1	10/25/74	37° 27	106° 53	7,800	Mineral
Castle Creek	CASTLE	6143	NP3	10/24/74	37° 12	106° 45	9,100	Archuleta
Jersey Jim	JERJIM	6202	JC2	Not In	37° 30	108° 11	10,000	Montezuma
Muleshoe	MULSUE	6212	FG6	Not In	37° 52	107° 45	12,800	San Juan

Table 1: 1974-75 Winter LANDSAT Station Data

Table 2 lists the locations and parameters measured during the 1973-74 winter, and the changes in station configuration for the 1974-75 winter season. The Palisade Lakes and Runlett Park sites were eliminated from the present network as they were part of the existing ground link data network. The primary change in data parameters is the development of a system for obtaining wind speed and wind direction averaging as the average values are much more useful than instantaneous values in operational forecasting. Work on the fabrication and testing of this system is still in progress.

The two new locations selected as LANDSAT Data Collection sites for the 1974-75 winter season are Upper San Juan and Jersey Jim. Upper San Juan is located approximately two miles west of the summit of Wolf Creek Pass near an established Soil Conservation Service snow course. The Data Collection Platform and sensors were moved from Palisade Lakes to this new location to provide additional near real-time data from the heart of the target area of the Colorado River Basin Pilot Project. The Jersey Jim site is located to the west of the target area and offers good exposure to approaching weather systems.

Five of the seven LANDSAT data stations listed in Table 1 were installed and operating prior to the beginning of the present reporting period. These stations were Lime Mesa, Upper San Juan, Wolf Creek Pass, Wolf Creek North, and Castle Creek. The remaining two stations, Jersey Jim and Muleshoe, will not be installed until the work on the wind speed and direction averaging system is completed. The installation, calibration, and maintenance of the LANDSAT Data Collection Platforms, as well as the development of the wind averaging system, is being accomplished by Bureau contractor Western Scientific Services, Inc. (WSSI).

III. Performance of the LANDSAT Data Collection System

The LANDSAT Data Collection System is presently receiving hydrometeorological data from 5 Data Collection Platforms located in the San Juan Mountains. Readings are obtained from the sensors at 90 or 180 second intervals, and broadcast by an on-site transmitter. The polar orbit of the LANDSAT satellite allows for two periods of data relay each day. Once the data are received at a ground receiving station, they are routed via landline communications to a Bureau computer located at the Denver Federal Center, Denver, Colorado. The LANDSAT data are available to users having a time-share computer terminal as soon as three hours after transmission. The following paragraphs give a site-by-site summary of the performance of the 5 Data Collected Platforms which were operated during the present reporting period.

Table 2: LANDSAT Follow-on Program Changes in
Station Configuration

<u>1973-74 Winter</u>		<u>1974-75 Winter</u>	
Site	Parameters	Site	Parameters
Lime Mesa	Temperature Precipitation Battery voltage	Lime Mesa	No Change No Change No Change
Palisade Lakes	Temperature Precipitation Snow Pillow Battery voltage	Upper San Juan	Temperature Precipitation Snow Pillow Battery voltage
Wolf Creek Pass	Temperature Precipitation Battery voltage	Wolf Creek Pass	No Change No Change No Change
Wolf Creek North	Streamflow Water Temperature Battery voltage	Wolf Creek North	No Change No Change No Change
Castle Creek	Temperature Precipitation Battery voltage	Castle Creek	No Change No Change No Change
Runlett Park	Temperature Wind Speed Wind Direction Relative Humidity Battery voltage	Jersey Jim	Temperature Ave. Wind Speed Ave. Wind Direction Relative Humidity Battery voltage
Muleshoe	Temperature Wind Speed Wind Direction Radiation Relative Humidity Rime Ice	Muleshoe	No Change Ave. Wind Speed Ave. Wind Direction No Change No Change Omit

A. Lime Mesa - The Data Collection Platform at this site was fully operational on January 1, 1975. There have been no breaks in data transmission due to system problems. This high remote site was serviced by helicopter on January 3, February 9, and March 2, 1975. The temperature and precipitation data received from this site via the LANDSAT satellite appear to be of very high quality.

B. Upper San Juan - The Data Collection Platform at this site was fully operational on January 1, 1975. Initial snow-pack water content readings from the snow pillow were considerably higher than manual readings from the Soil Conservation Service snow course; therefore, the snow pillow was recalibrated on January 7, 1975. During late January the Soil Conservation Service reported that a large tree had fallen on the chart recorder for the Upper San Juan snow pillow data and had damaged it considerably. Attempts were made to repair the recorder on site, however, subsequent data which have been received from the snow pillow do not appear to be accurate. Temperature and precipitation data have been transmitted continuously from this site and appear to be of very high quality. The site was serviced on January 7, February 3, and March 14, 1975.

C. Wolf Creek Pass - The Data Collection Platform at this site was fully operational on January 1, 1975. There have been no breaks in data transmission due to system problems. This LANDSAT DCP was serviced on January 18, February 4, February 22, and March 13, 1975. On February 22nd, the precipitation and temperature sensors were raised to keep them above the snowpack. The data received from this site via the LANDSAT satellite appear to be of very high quality. The co-location of a standard recording precipitation gage at this site (part of the instrument network for the Colorado River Basin Pilot Project) allows for comparison of the LANDSAT precipitation data. Figure 2 shows the comparison of LANDSAT and standard recording gage precipitation data for the one week period beginning at 1200 MST on January 1 and ending at 1200 MST on January 8, 1975. During this period the LANDSAT gage indicated an accumulation of 1.31 inches water equivalent while the standard gage recorded an accumulation of 1.24 inches water equivalent, for a difference of 5.6 percent. This difference could be the result of slightly different gage exposure and gage resolution.

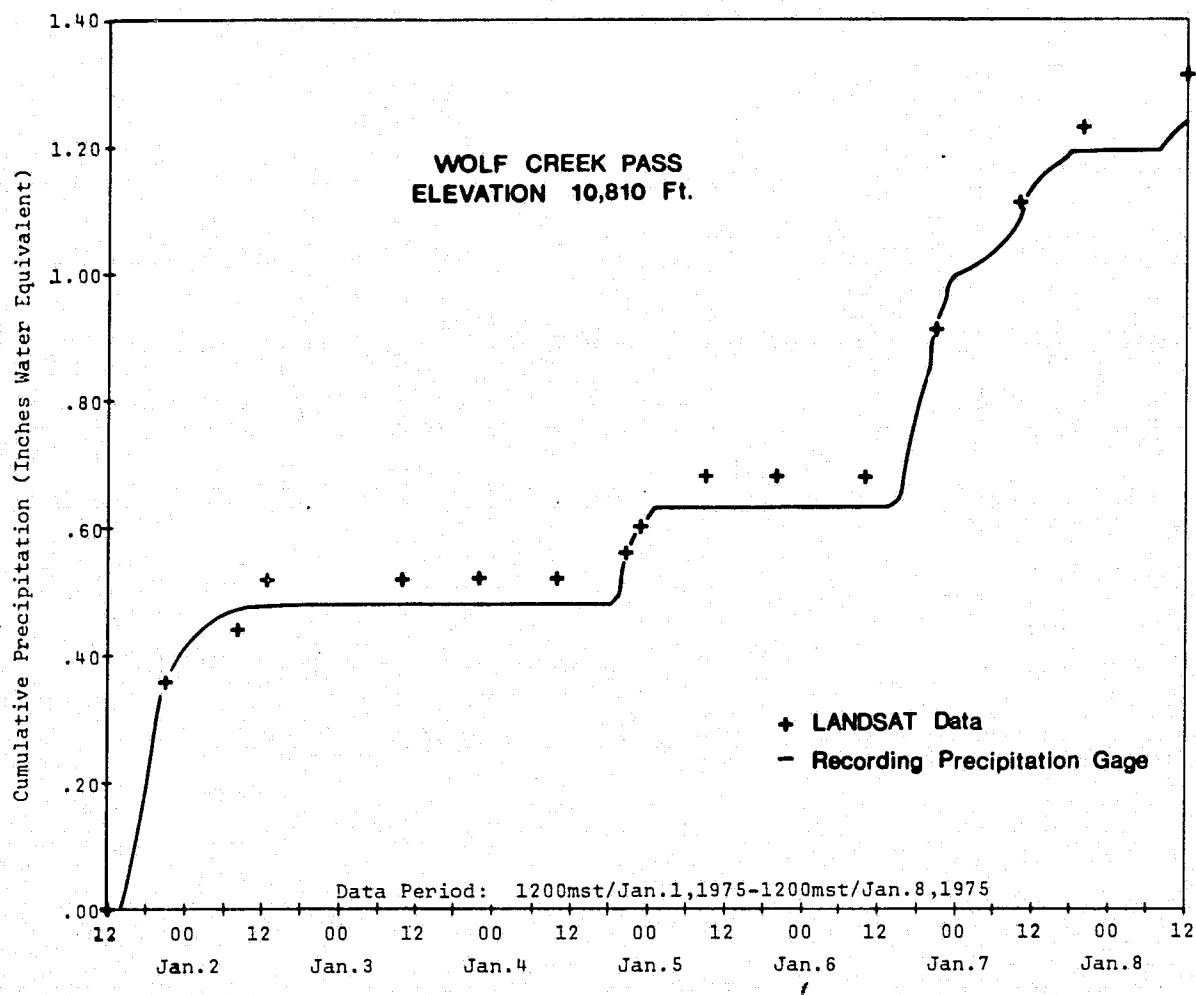


Figure 2: Comparison of Recording Gage and LANDSAT Precipitation Data

D. Wolf Creek North - The Data Collection Platform at this site was fully operational on January 1, 1975. The stream-flow and water temperature data looked good until January 26th when the water temperature sensor malfunctioned. WSSI technicians visited the site on March 7, 1975, but were neither able to repair the sensor or remove it due to the cable being buried under the snowpack for a considerable distance. The decision was made to leave the water temperature sensor as it is until it can be easily removed for repair later in spring. The streamflow data have been received from this site on a regular basis during this reporting period.

E. Castle Creek - The Data Collection Platform was removed from this site during December for shop checkout and was not reinstalled until January 26, 1975. It was necessary to return to the site on February 4 to complete the installation of the temperature sensor. The remote LANDSAT DCP was serviced by an over-snow vehicle on March 13, 1975. Precipitation data have been received from this site via the LANDSAT satellite on a regular basis since January 26th, and appear to be of very good quality. Temperature data received since February 4th are warmer than expected. The calibration of the temperature sensor will be checked so that data which have been received can be corrected accordingly.

IV. Development of Wind Averaging System

An important step toward making the LANDSAT Data Collection System an operational tool in weather analysis and forecasting is the development of a system for obtaining wind speed and wind direction averaging and hourly data storage. The system currently being developed by WSSI provides a 10 minute average of wind speed and wind direction once per hour. The wind speed sensor is an MRI Model 1022S cup anemometer with a photo-chopper circuit which provides a sine wave output whose frequency is directly proportioned to the speed of rotation of the anemometer shaft. The wind direction sensor is an MRI Model 1022D-1 which utilizes a single-blade magnesium tail vane and incorporates a combined nose damping vane with static balance. A sine/cosine azimuth transducer is mounted with a solid coupler to the vane idler shaft inside the sensor main housing. This transducer is a continuous rotation 360° potentiometer (geared one-to-one with the sensing vane) which has a center tap and two wipers set at 90° to one another. When the vane is rotated clockwise, the cosine wiper trails the sine wiper by 90°.

The wind averaging circuits convert the sine and cosine wind direction outputs to pulse rates which are directly related to the sensor position. The sine and cosine outputs are averaged over a 10 minute interval by integrating the output pulse rates. The integrated sine and cosine values are examined at the end of the integration period to determine average wind direction, and the 8 bit binary number representing average wind direction is then stored in memory. During the wind direction integration the wind speed output is also integrated and, at the completion of the integration period the 8 bit binary number representing average wind speed is also entered into the system memory.

The system memory stores data for 8 hourly samples. Each hour the oldest wind speed and wind direction values are replaced by the current values. For use with the LANDSAT system, wind values from two hourly samples and an identifier are transmitted during each LANDSAT transmission. The identifier indicates the relation of the transmitted data to the current time interval. LANDSAT DCP transmissions will be set at 90 second intervals so that a complete set of average wind speed and average wind direction data for the last eight hours is transmitted by the LANDSAT DCP every 6 minutes.

V. Progress Planned for Next Reporting Period

Work items planned for the April 1 through June 30, 1975 period include the following:

- A. Routine servicing of the 5 LANDSAT stations in operation during the present reporting period.
- B. Calibration of the Castle Creek temperature sensor.
- C. Repair of the Wolf Creek North water temperature sensor.
- D. Shop tests of two of the wind averaging systems.
- E. Installation of LANDSAT Data Collection Platforms and sensors at the Muleshoe and Jersey Jim sites (see Figure 1).
- F. Field tests of the prototype wind averaging systems at Muleshoe and Jersey Jim.
- G. Evaluation of the relative humidity sensor and improve data accuracy if possible.
- H. Continued use of LANDSAT data in near real-time to monitor weather conditions for cloud seeding control.

e. Significant Results:

Significant results of this investigation to date are:

1. The LANDSAT Data Collection System has proven itself to be a valuable tool operationally by the Bureau's cloud seeding contractor for control of cloud seeding operations and for verification of weather forecasts.

2. The Data Collection Platforms have proven to be reliable weather resistant units suitable for the collection of hydrometeorological data from remote, severe weather environments.

3. The detailed design of the wind speed and direction system and the wire-wrapping of the logic boards were completed.

f. Publications:

There were no published articles, and/or papers, pre-prints, inhouse reports, or abstracts of talks that were released during the reporting period.

g. Recommendations: None

h. Funds Expended:

Total expenditure on this investigation through March 15, 1975 is \$7,622.

i. Data Use: N/A

j. Aircraft Data: N/A